
Transmission considerations for remote network access

One application of private networks is to reduce toll charges on public network to public network calls. The user in the public network makes a local or toll-free (INWATS) call to one of the private network switches, then calls to an off-network destination via either Direct Inward System Access (DISA) or attendant assistance.

Gain

The public network transmission plan does not support tandems of two or more connections. Such tandems inherently occur when using the private network to make a public network to public network call. The loss can be partially offset by gain.

Public network to public network calling via the private network has relatively small usage and savings, so it does not justify a change to the private network transmission plan. Instead, gain is applied on the access trunks, which are used exclusively for incoming calls. The gain is applied independently of the connection established through the private network. Thus, the amount of gain provided is a compromise that optimizes grade of service on the more important connections but possibly degrades service on some others.

Gain devices

The gain required is bidirectional between 2-wire interfaces and is provided by devices called repeaters. There are two types of suitable bidirectional gain devices: fixed and switched gain. Fixed-gain devices are extremely sensitive to impedance mismatches at the 2-wire interfaces. Such mismatches can cause oscillation. Switched-gain overcomes the oscillation problem, but introduces speech impairments due to the switching action.

Fixed gain

You can implement bidirectional fixed gain by adding either an amplifier on a 2-wire path or two unidirectional amplifiers in a 4-wire arrangement, interfacing the 2-wire path through hybrids. Both schemes are sensitive to the impedances at the 2-wire interfaces. Adjustable matching networks are required to allow the device to interface a variety of facilities.

The more gain required, the closer you must match the impedances to the interfaces to prevent oscillation or poor transmission associated with near oscillation. The impedance at the interfaces is partly determined by the impedances of facilities switched into a connection. Ultimately, those impedances limit the practical gain.

Voice-switched gain

The voice-switched gain amplifier avoids stability problems by applying gain dynamically. Only one direction of transmission can have gain at a time. A loss equal to the gain is provided in the opposite transmission direction.

Gain is applied by monitoring for speech and applying gain in the talker-to-listener direction when speech is detected. In the idle mode, a small loss is inserted in both directions. Compensation for impedances is required for the direction sensing circuitry to function properly. [Table 13](#) compares fixed gain and voice-switched gain.

Gain with compression

On some connections, signal levels may already be high, and gain may increase the levels above FCC specified limits. Some manufacturers provide compression options to guard against exceeding FCC limits. Speech compression ensures that signal levels will not exceed a specified maximum, generally -9 dBm. When speech levels amplified without compression exceed that level, the gain is dynamically reduced so the output level does not exceed -9 dBm. The -9 dBm limit is specified in FCC requirements.

Gain with compression is possible on both fixed gain and voice-switched gain repeaters and does not change the adjustment procedure.

Table 13
Comparison of fixed gain and voice-switched gain

Fixed gain	Voice-switched gain
Does not degrade speech by gain switching action.	May degrade speed.
Must be permanently attached to a trunk and be adjusted for its impedance.	May be switched into connections as required, but is affected somewhat by facility impedance.
Is not sensitive to voice levels.	May require voice activation adjustment to provide required sensitivity.
May oscillate under certain circumstances.	Is “unconditionally” stable.
Is “transparent” to voiceband data and DTMF signaling.	Must be switched out for voice-band data and may impair DTMF signaling.

Recommendation

When the required test equipment is available and the type of facility provided by the telco is known, use fixed gain units because of their superior performance. Use switched gain units where transmission performance is not so critical or the more complex alignment procedure for fixed gain units cannot be performed.

Adjustment

The gain should be set initially to 6 dB in each transmission direction. This value of gain is a compromise between optimized grade of service and practical considerations of avoiding oscillation and other transmission impairments. Based on experience, you may then adjust the gain to greater or less than 6 dB.

Application to trunks

To minimize the effect on the overall transmission plan, install the gain units only on trunks used to access the network primarily for calling via tie trunk facilities or to off-network destinations. Calls originated on-network are to be blocked from accessing these trunks.

Arrange one-way incoming Direct Inward System Access (DISA) central office trunk (COT) groups, using ground start trunks. The trunks are used for calling over tie trunks and off-network. Calls terminating on the same PBX should be placed by the attendant or direct inward dial (DID) trunks, if provided.

When DISA is equipped on DID trunks, do not provide gain units. DID trunks carry traffic both to telephones and DISA, and gain is not desirable for the traffic to telephones. Instead, add a new ground-start CO trunk group and move DISA to that group. Gain units can then be provided on that group.